



# Ecosystems Approach to Assess Multispecies Fisheries Risks from Exploitation and Environmental Changes

Jerald S. Ault, Jiangang Luo, & Steven G. Smith

University of Miami

Department of Marine Ecosystems & Society

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ATMOSPHERIC SCIENCE



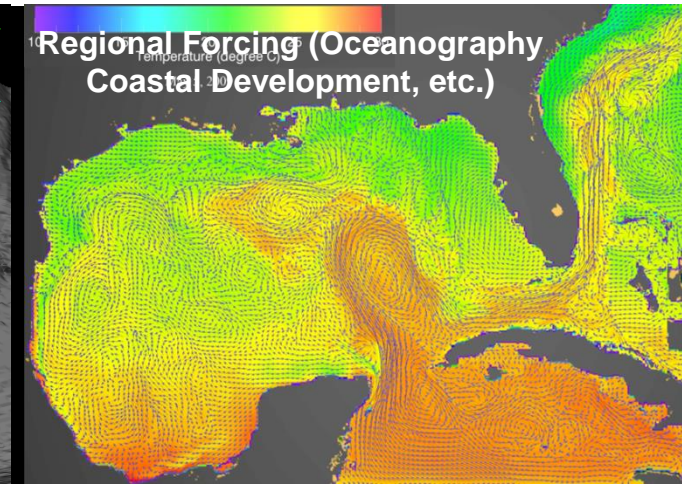
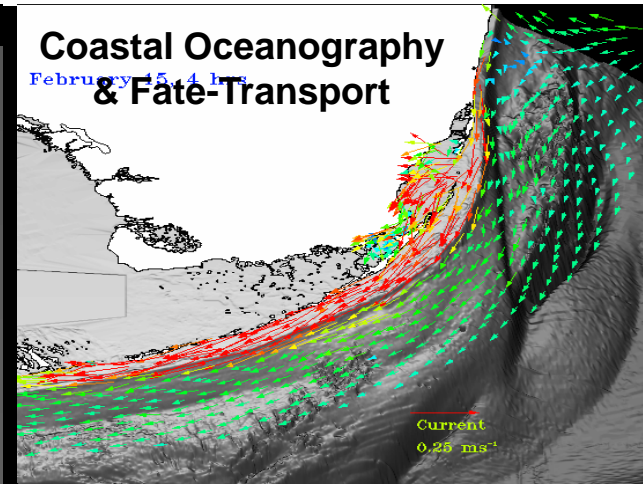
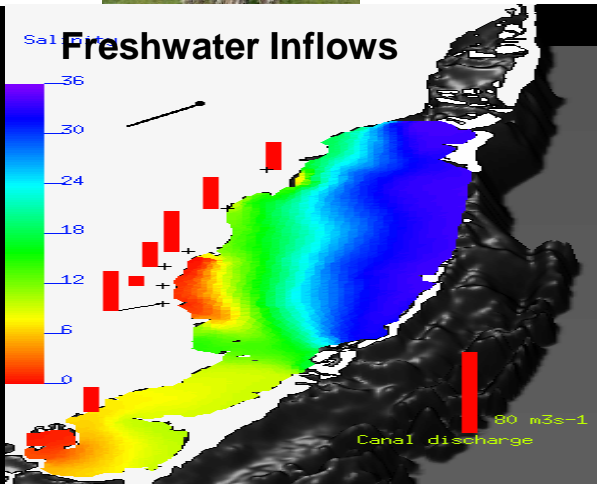
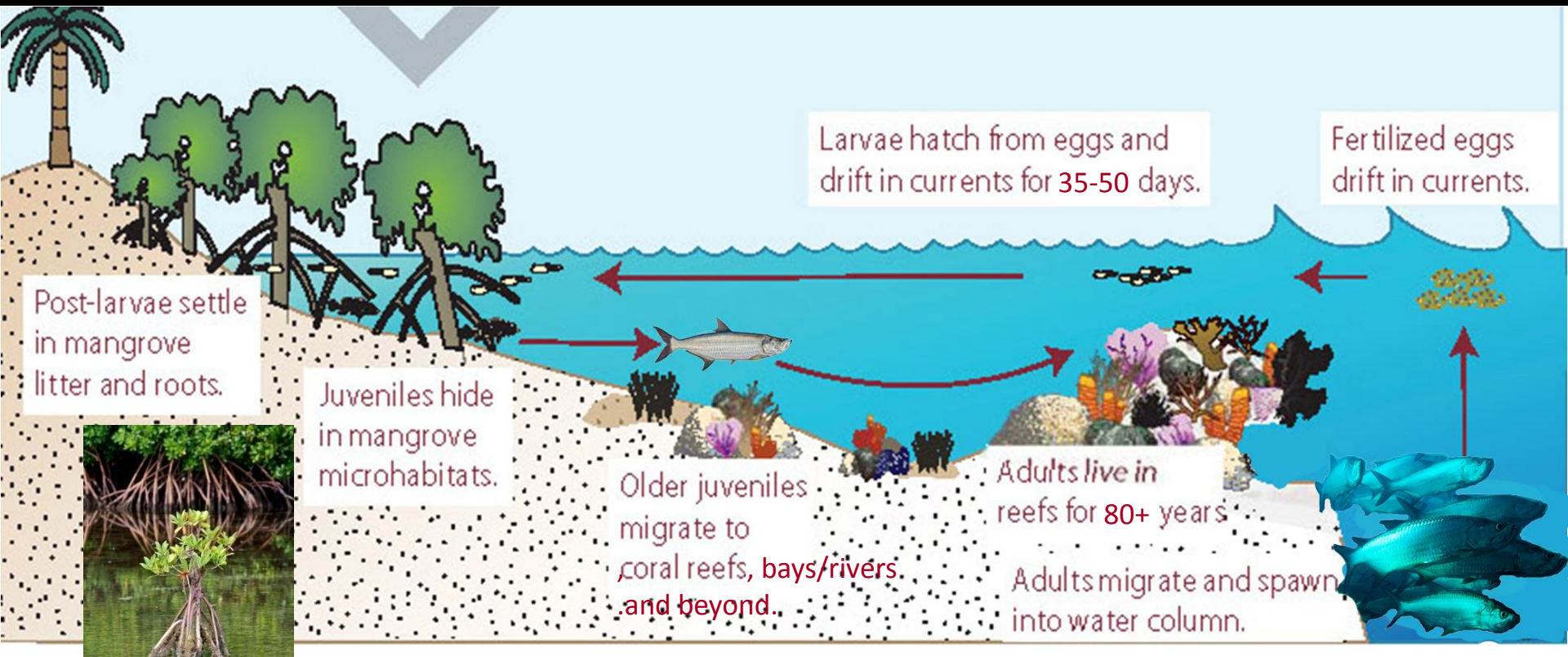


An underwater photograph of a vibrant coral reef. In the foreground, there are large, textured coral structures in shades of orange, brown, and green. The background is a deep blue ocean with a school of silver fish swimming towards the right. The text is overlaid in the center in a bold, white, sans-serif font.

WE HAVE TO  
**CHANGE**  
THE WAY WE  
THINK ABOUT  
**FISHERIES SCIENCE**



# Coastal Oceanography & "Habitat" Use Ontogeny



# Multispecies Population Conservation Equations

## (1) Abundance (numbers-at-age $a$ for cohort $i$ )

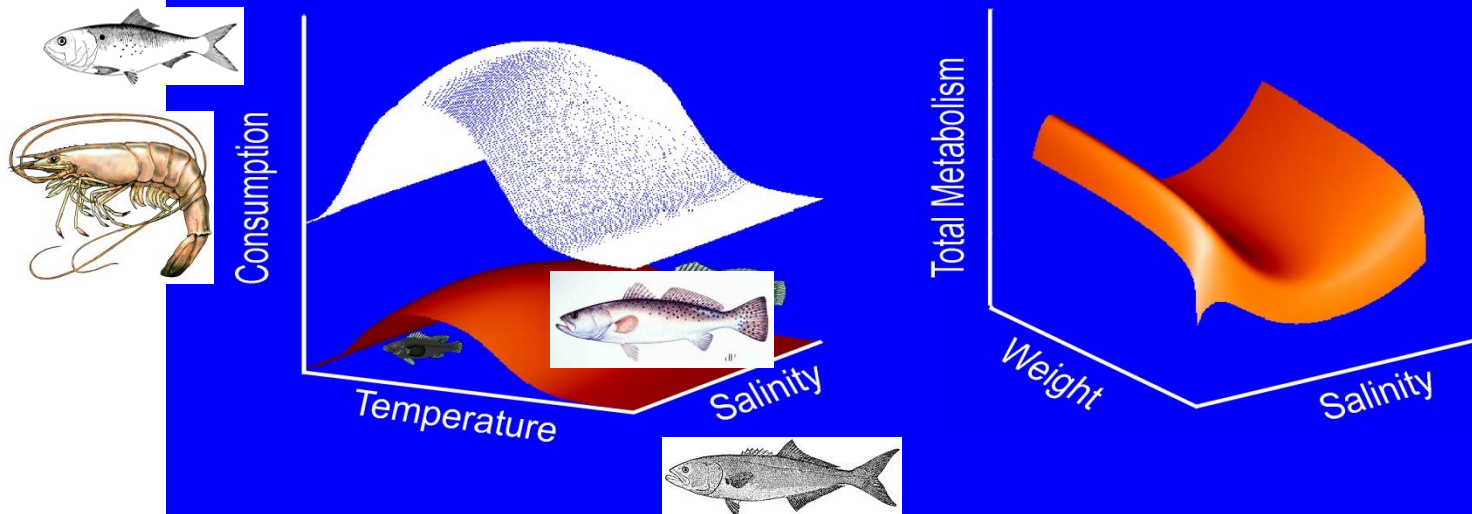
$$\frac{dN_i}{dt} = \left( \frac{\partial N_i}{\partial a} da + \frac{\partial N_i}{\partial t} dt \right) + \text{advection} + \text{diffusion} + \text{taxis/kinesis}$$

Predator-Prey  
Reaction Kinetics

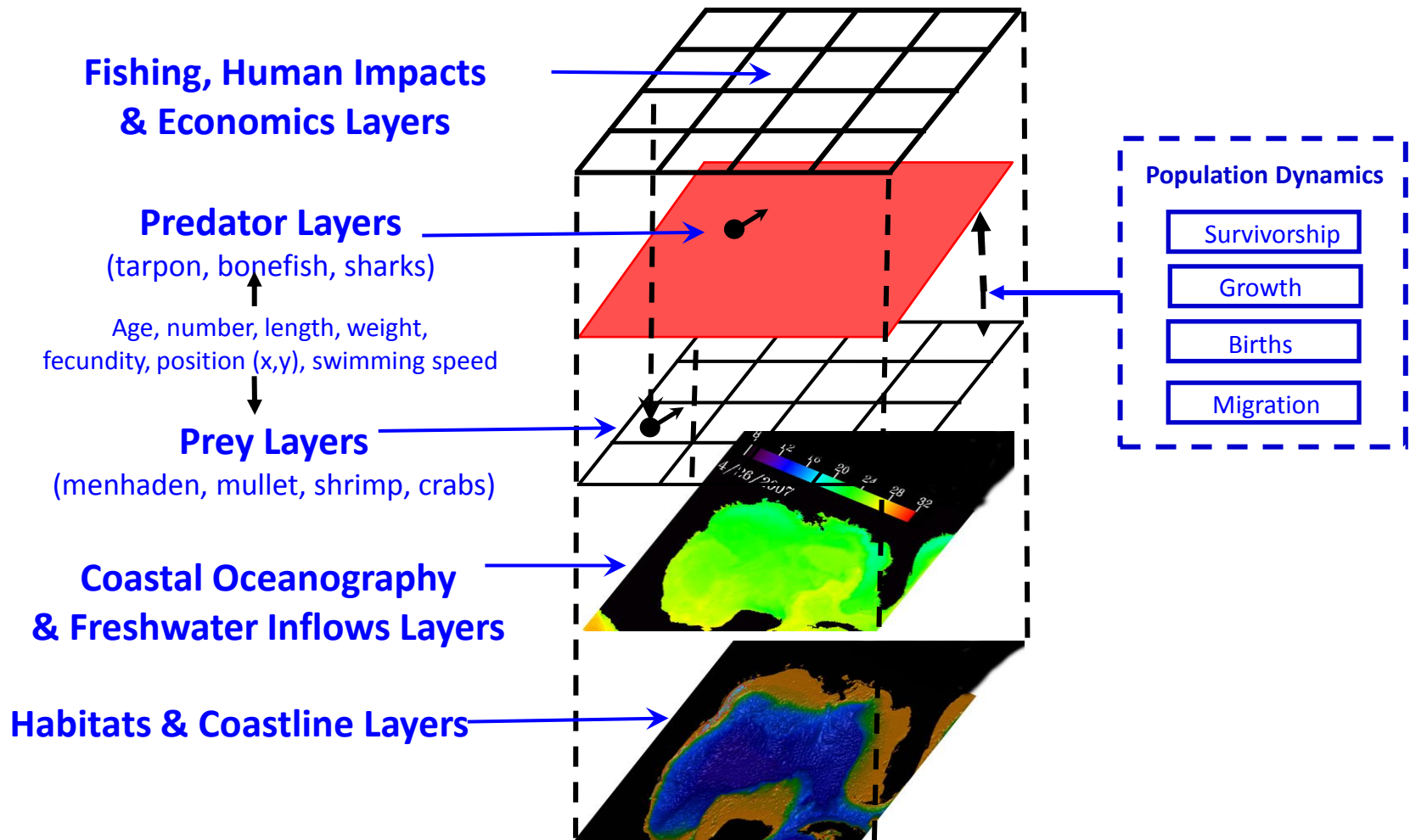
Drift, Density-dependent Competition &  
Environmental "habitat" Preferences

## (2) Individual Weight-at-age (to population biomass)

Bioenergetics:  $dW/dt = \text{anabolism} - \text{catabolism}$



# *21<sup>st</sup> Century Scientific Challenge to Achieve Fishery Sustainability*





# Independent data

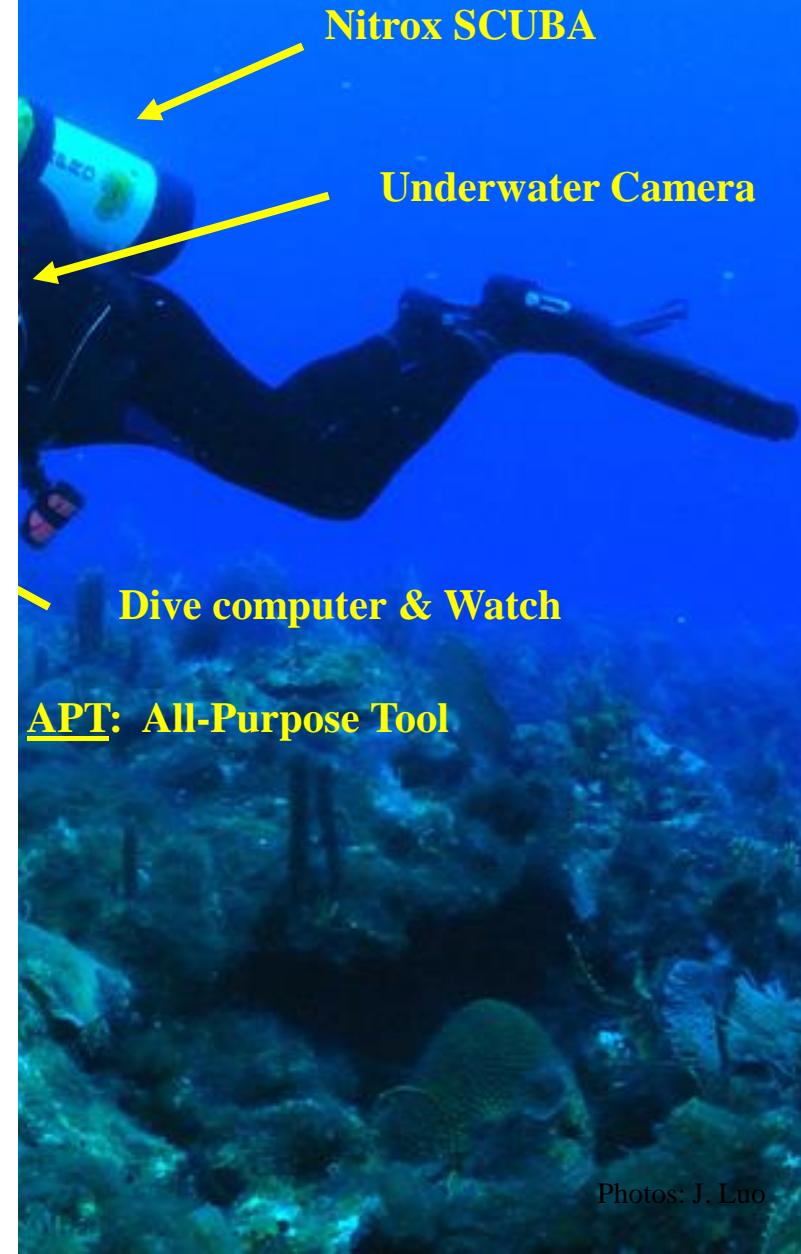
National Park Service  
U.S. Department of the Interior

Natural Resource Program Center



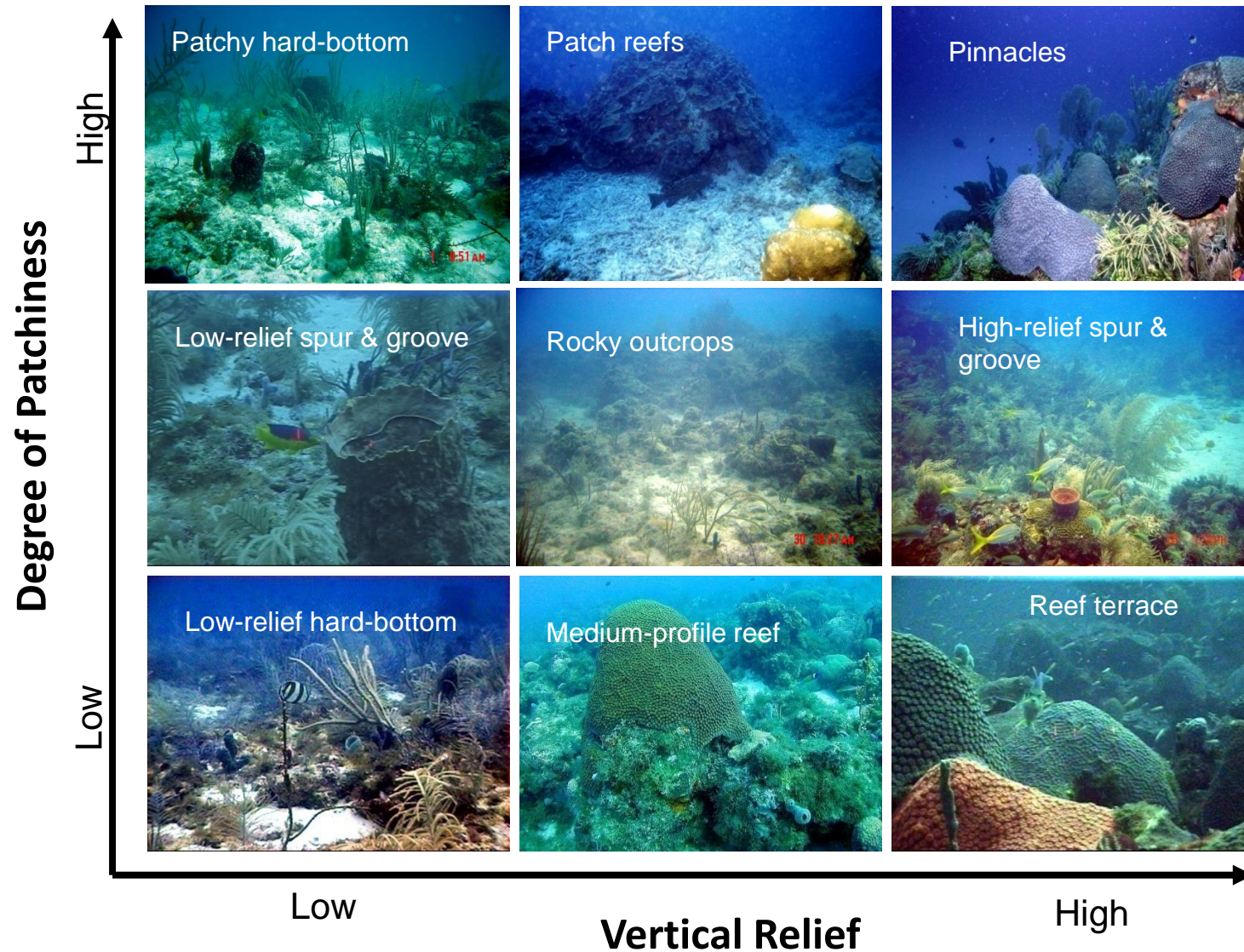
## A Cooperative Multi-agency Reef Fish Monitoring Protocol for the Florida Keys Coral Reef Ecosystem

Natural Resource Report NPS/SFCN/NRR—2009/XXX (FOR PEER REVIEW)



Photos: J. Luo

# Linking Reef-Fish Spatial Abundance & Benthic Habitats

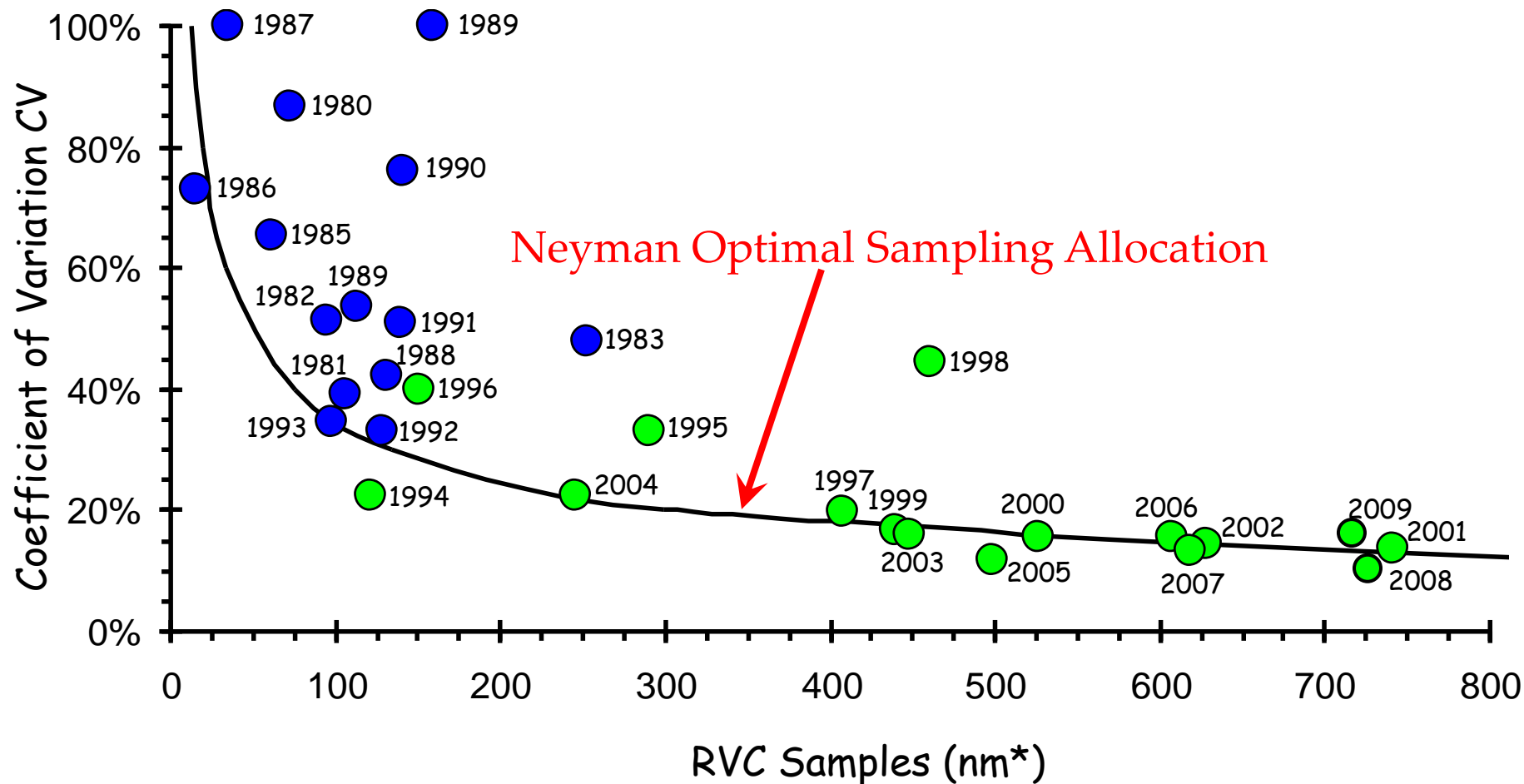


Smith, Ault, Bohnsack et al. 2011. *Fisheries Research*

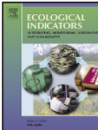
Franklin, Ault, Smith, Luo, Bohnsack et al. 2003. *Marine Geodesy*



# Florida Keys Sampling Design Efficiency 1979-2010







# Indicators for assessing the ecological dynamics and sustainability of southern Florida's coral reef and coastal fisheries

J.S. Ault<sup>a,\*</sup>, S.G. Smith<sup>a</sup>, J. Browder<sup>b</sup>, W. Nuttle<sup>c</sup>, E.C. Franklin<sup>a</sup>, J. Luo<sup>a</sup>, C.T. DiNardo<sup>e</sup>, J.A. Bohnsack<sup>b</sup>

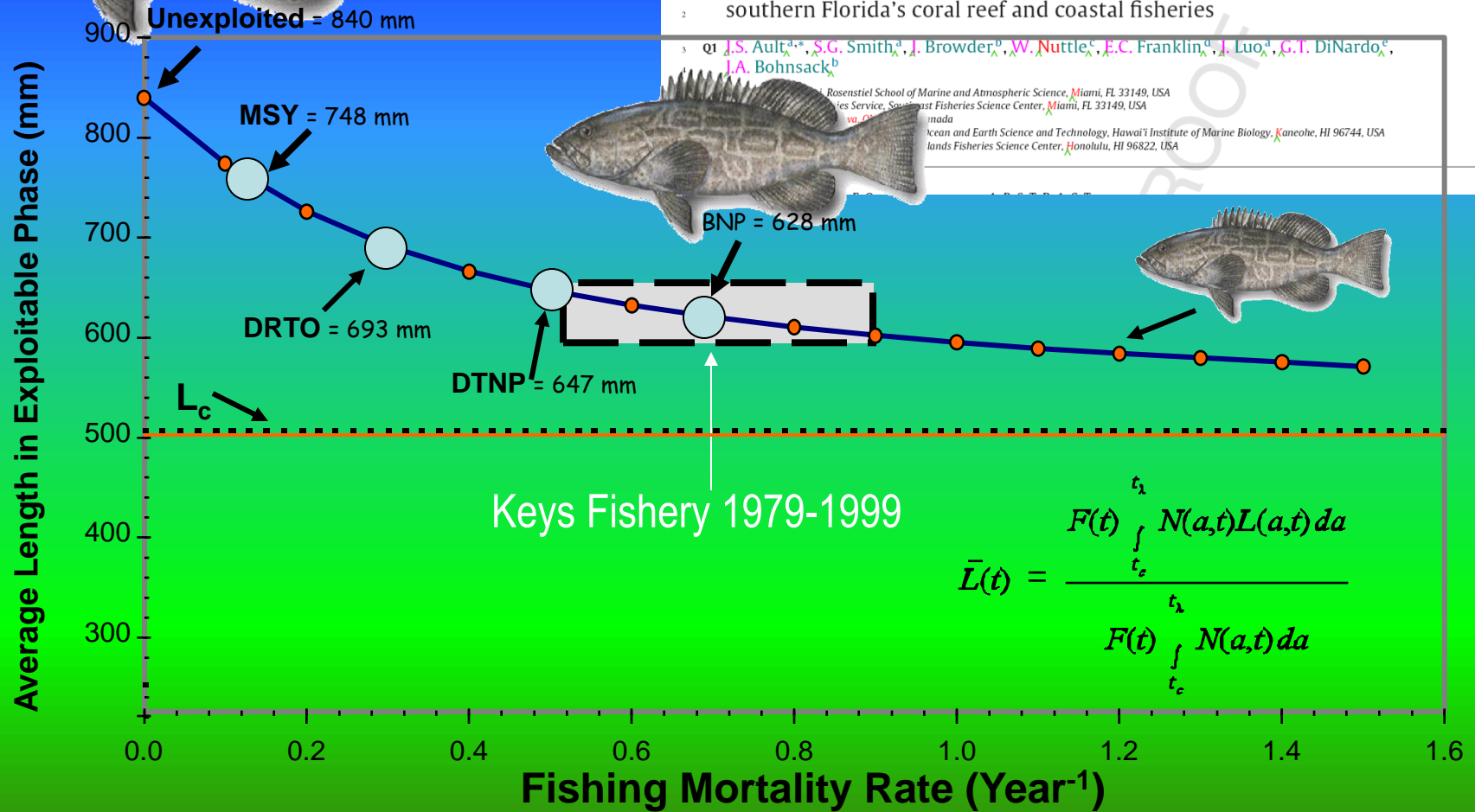
<sup>a</sup> Rosenstiel School of Marine and Atmospheric Science, Miami, FL 33149, USA

<sup>b</sup> Fisheries Service, Southeast Fisheries Science Center, Miami, FL 33149, USA

<sup>c</sup> NOAA

<sup>d</sup> Ocean and Earth Science and Technology, Hawai'i Institute of Marine Biology, Kaneohe, HI 96744, USA

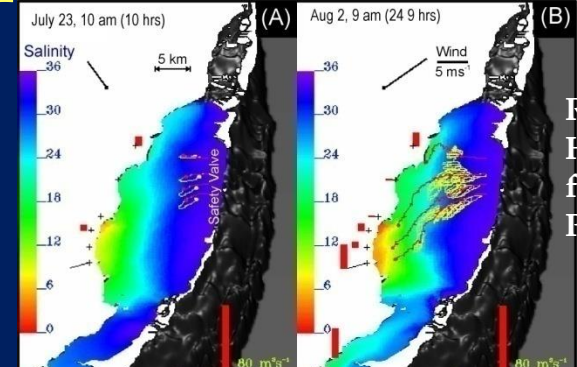
<sup>e</sup> Islands Fisheries Science Center, Honolulu, HI 96822, USA



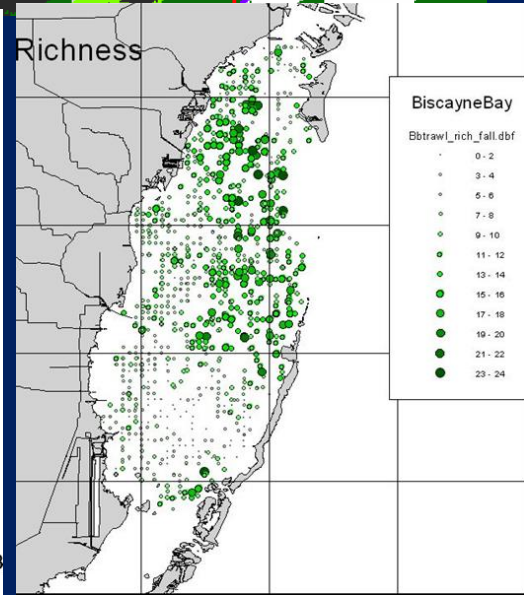
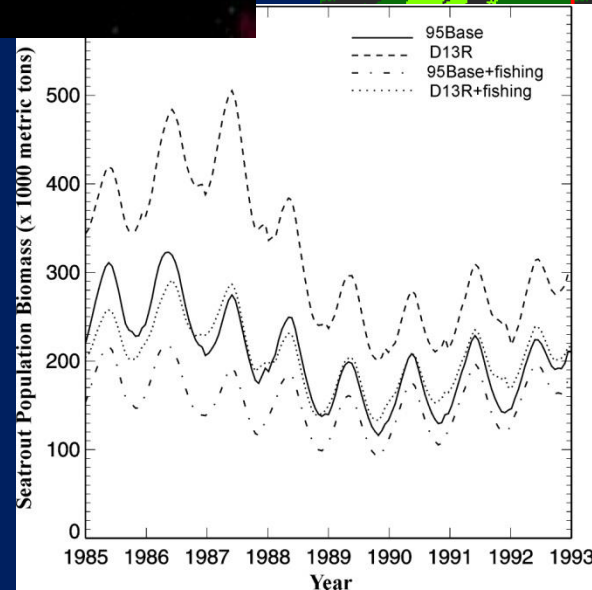
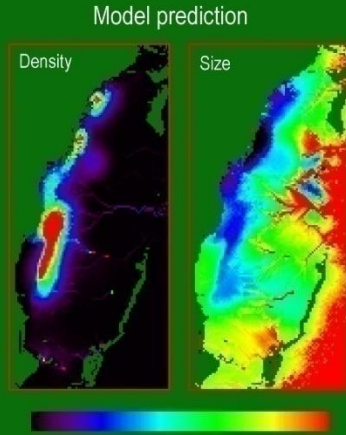
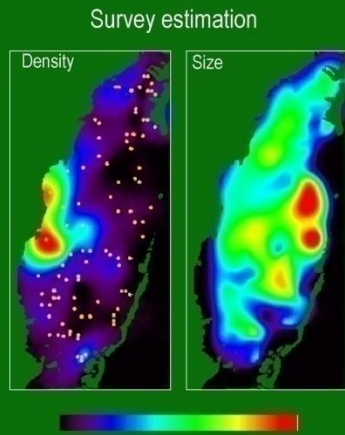
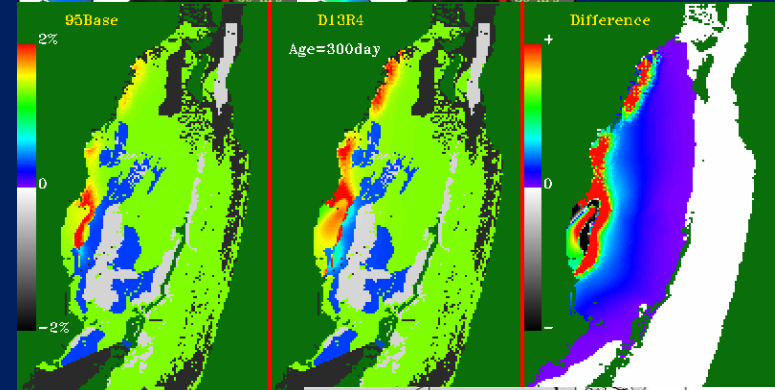
# Climate Changes and Fisheries Productivity

# SIPOM

Spatial Individual Patch Object Model

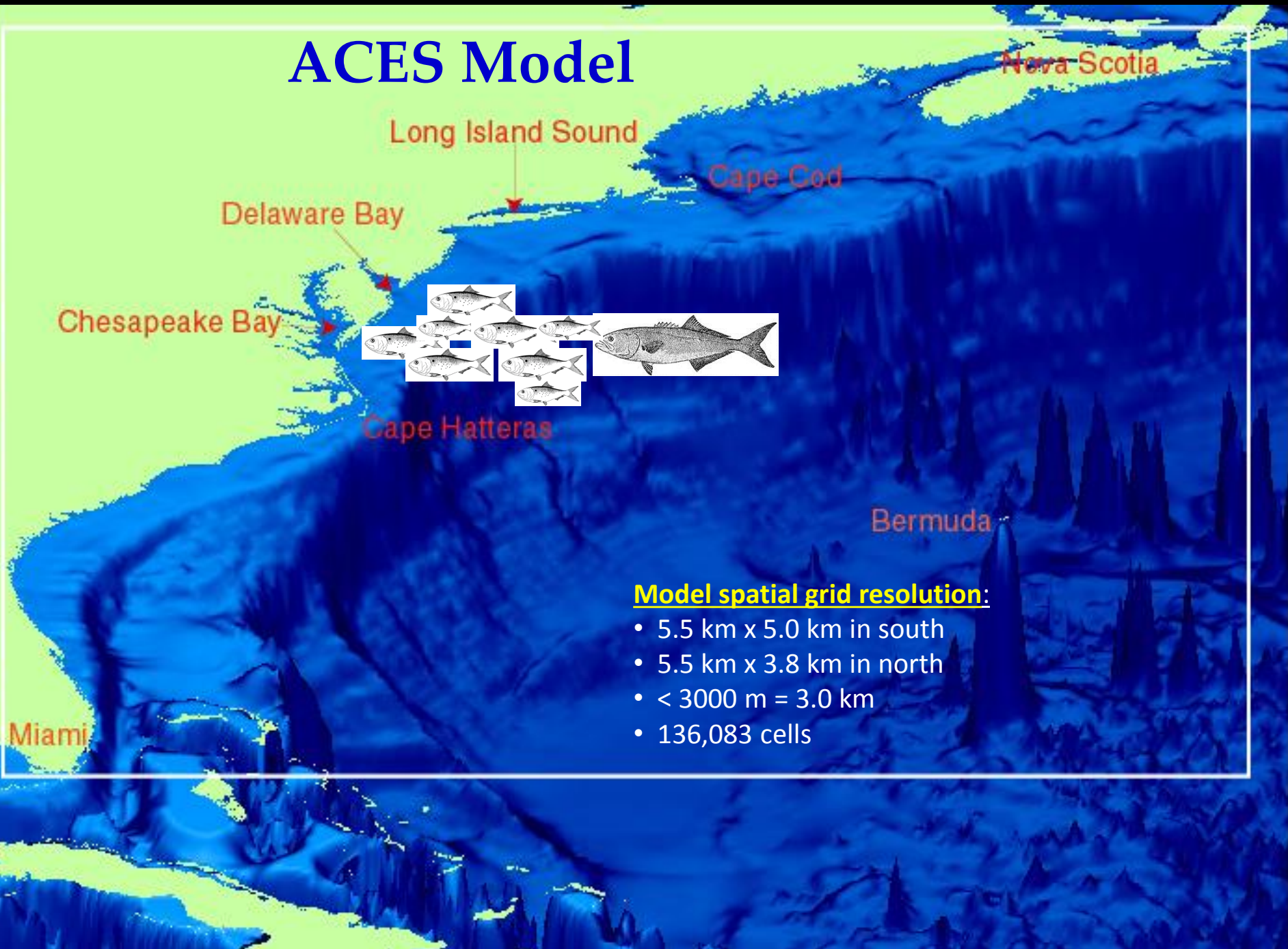


Recruitment & Habitat Quality for Population Productivity





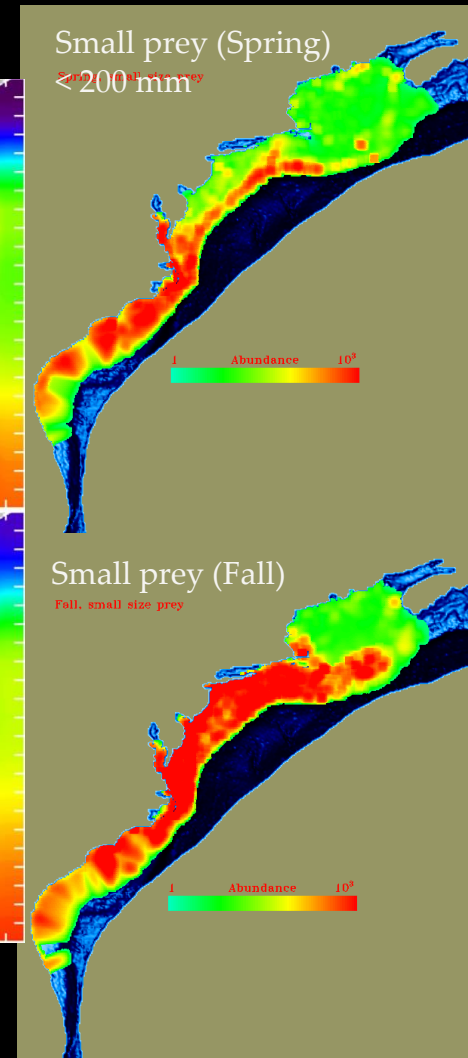
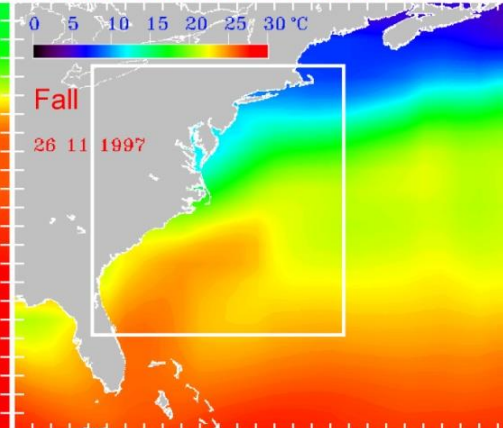
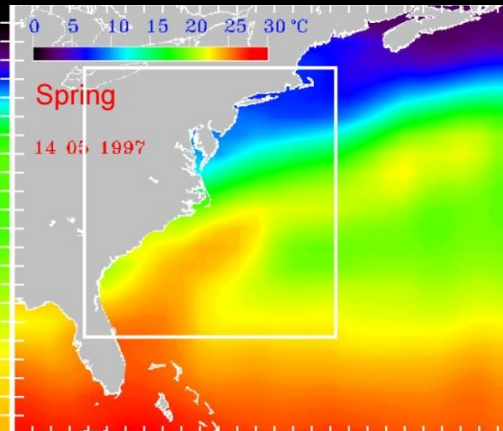
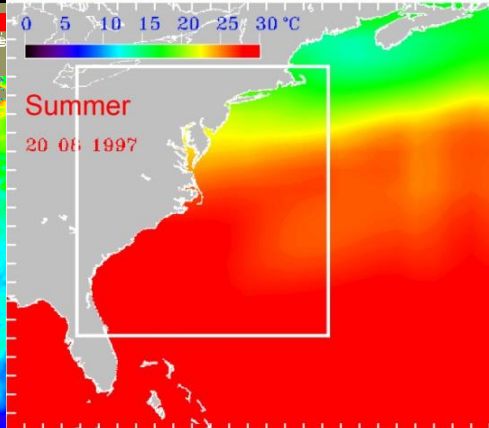
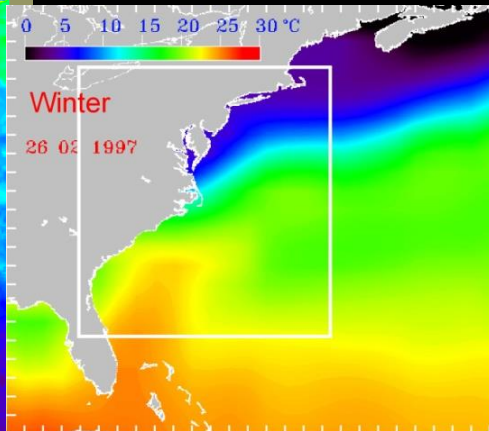
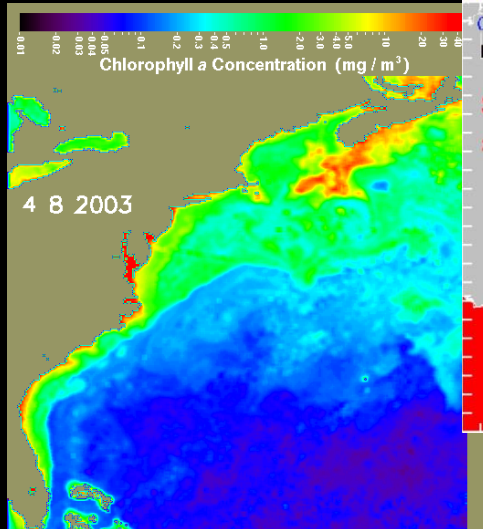
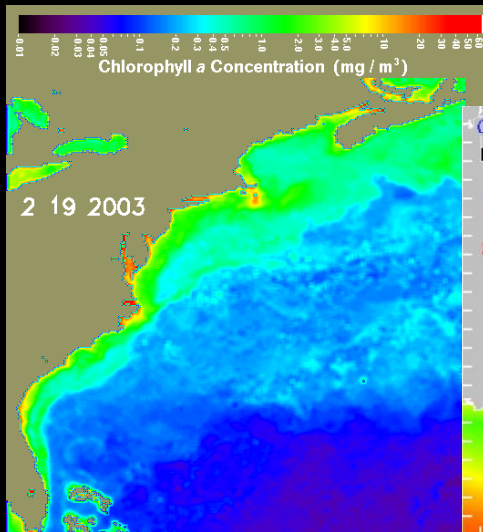
# ACES Model



## Chlorophyll a

## Sea Surface Temperature

## Prey Abundance



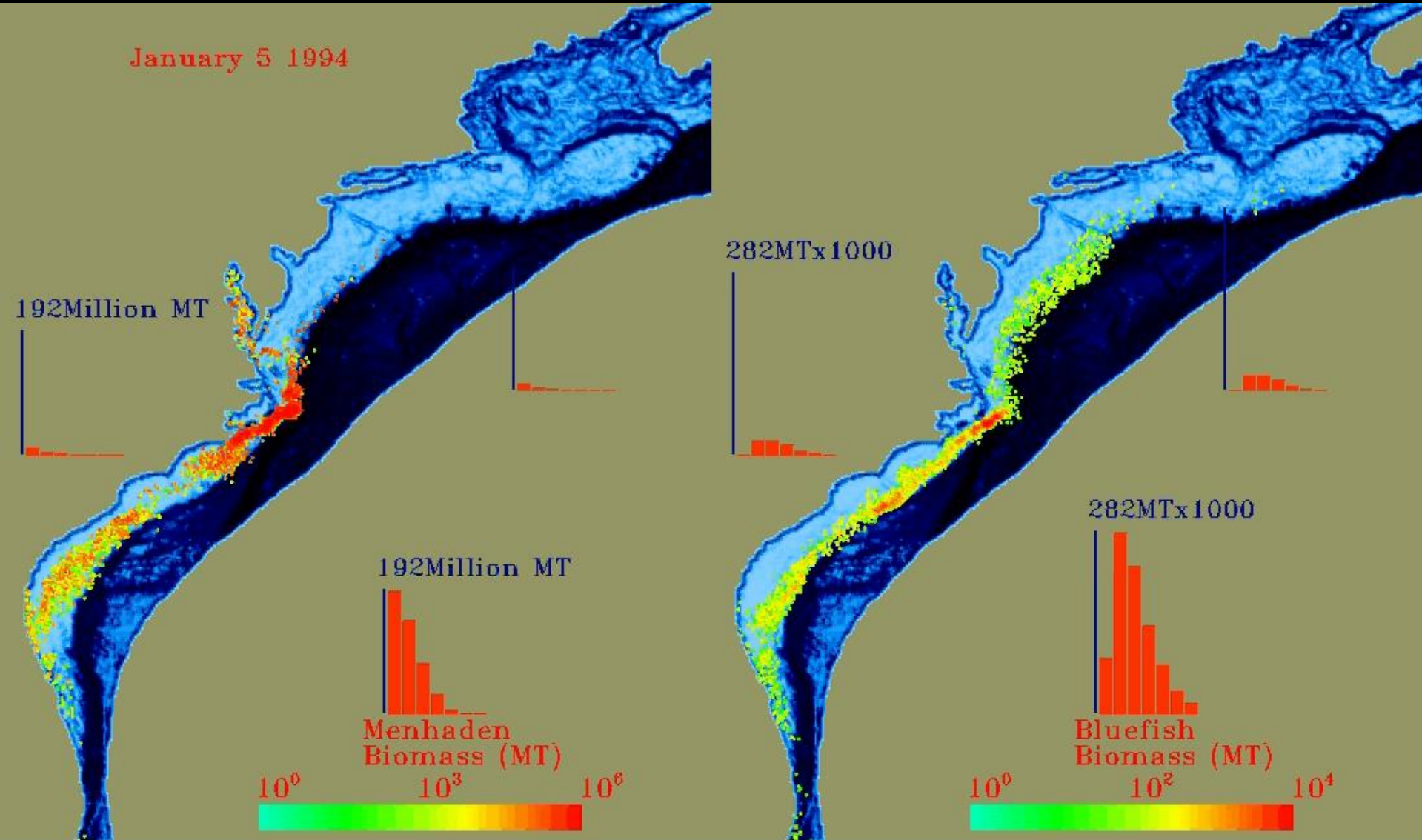


# ACES (Atlantic Coast Ecosystem Simulation) Model

## Menhaden Biomass

## Bluefish Biomass

January 5 1994





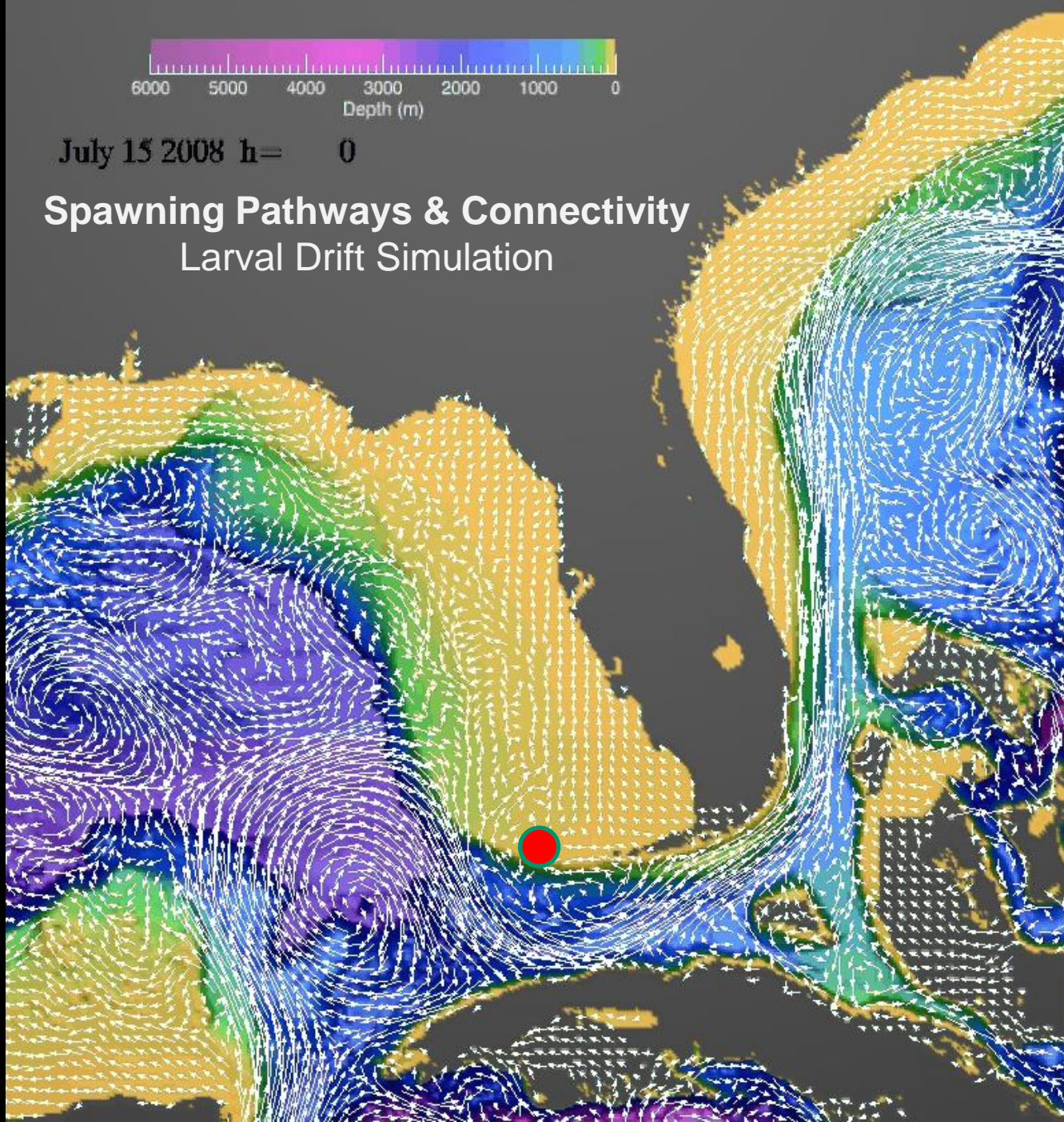


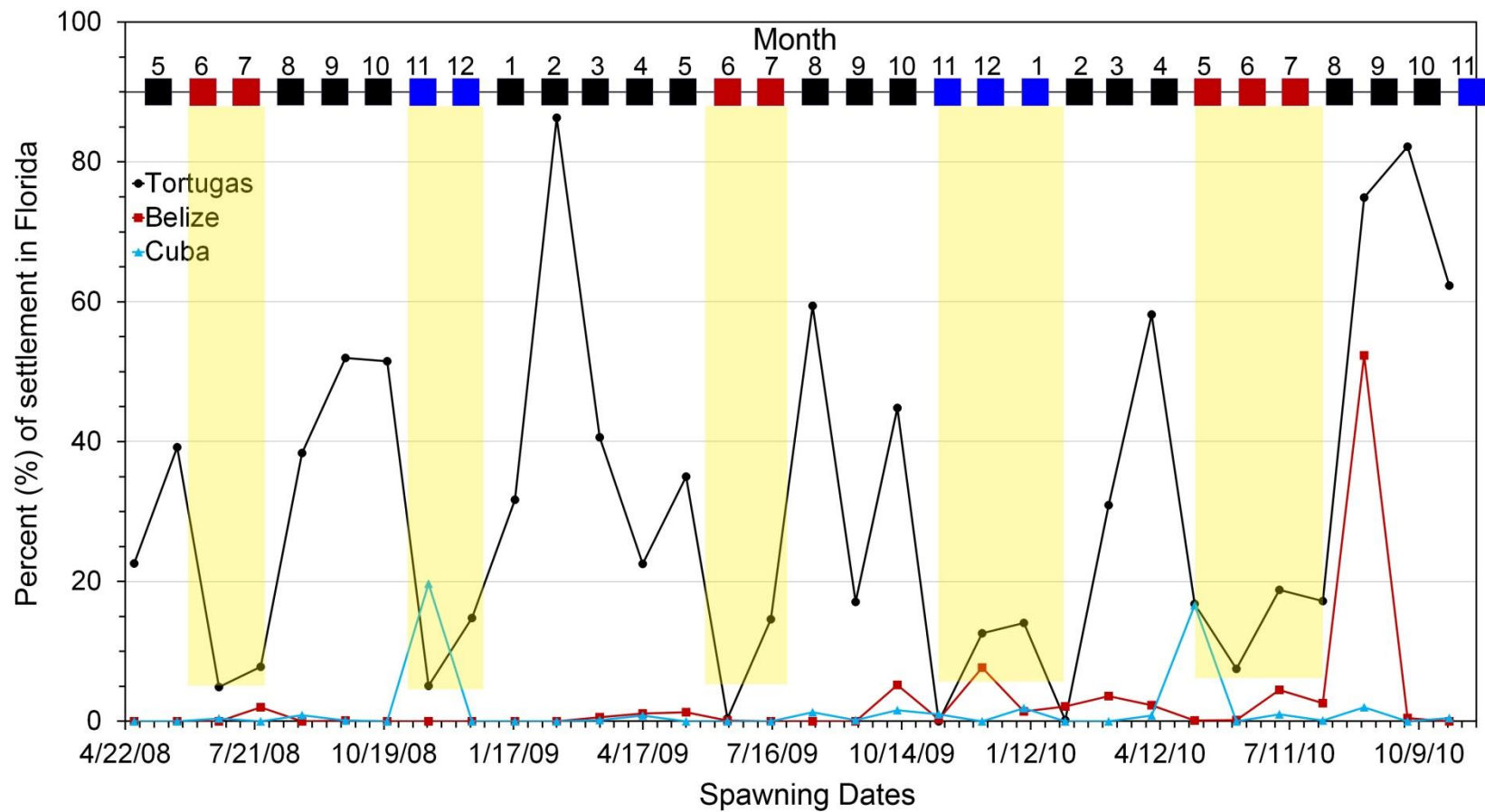




July 15 2008  $h=0$

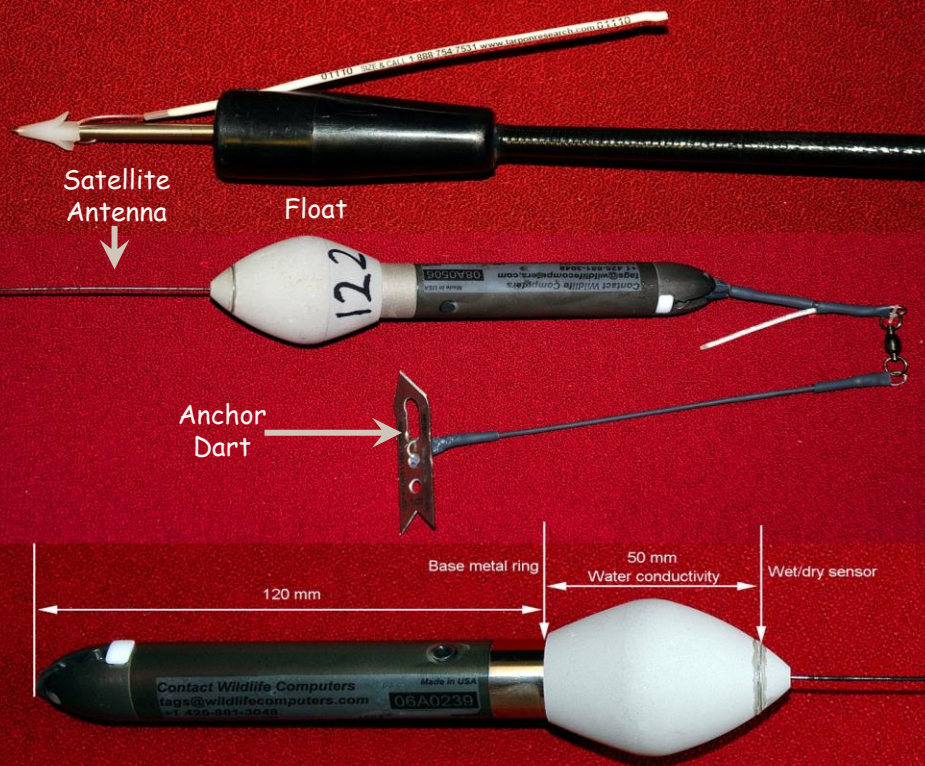
## Spawning Pathways & Connectivity Larval Drift Simulation







# Cost-effective use of satellite-based technologies to study migrations, habitat use and spawning areas



July 12, 2006

## Heroes of Conservation Photo Gallery



Photo: Dr. Jerald S. Ault

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doi: 10.3354/meps09957

MARINE ECOLOGY PROGRESS SERIES  
Mar Ecol Prog Ser

Published October 25



## Vertical movement rates and habitat use of Atlantic tarpon

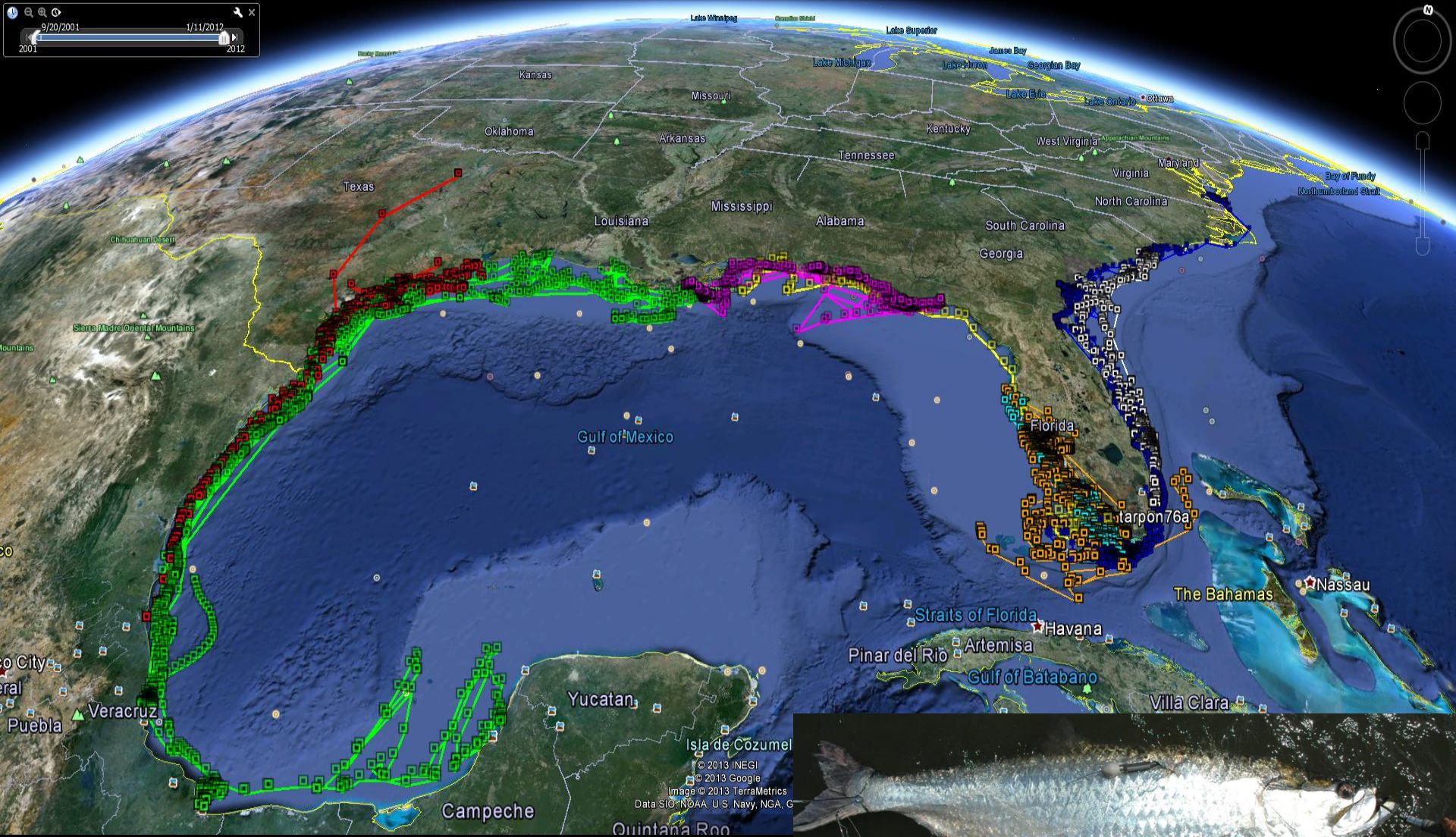
Jiangang Luo\*, Jerald S. Ault

University of Miami, Rosenstiel School of Marine and Atmospheric Science, Division of Marine Biology and Fisheries,  
4600 Rickenbacker Causeway, Miami, FL 33149, USA

**The Bonefish and Tarpon Conservation Research** crew from the University of Miami tag fish caught in a 2005 tarpon tournament in Veracruz, Mexico. An understanding of tarpon migration patterns and feeding habits is crucial to the fishery's offshore management. The group attached a Pop-up Archival Transmitting Tag to each fish behind its head.



# Documented travels of the mighty Atlantic Tarpon



Migrations, ocean habitat use & spawning,



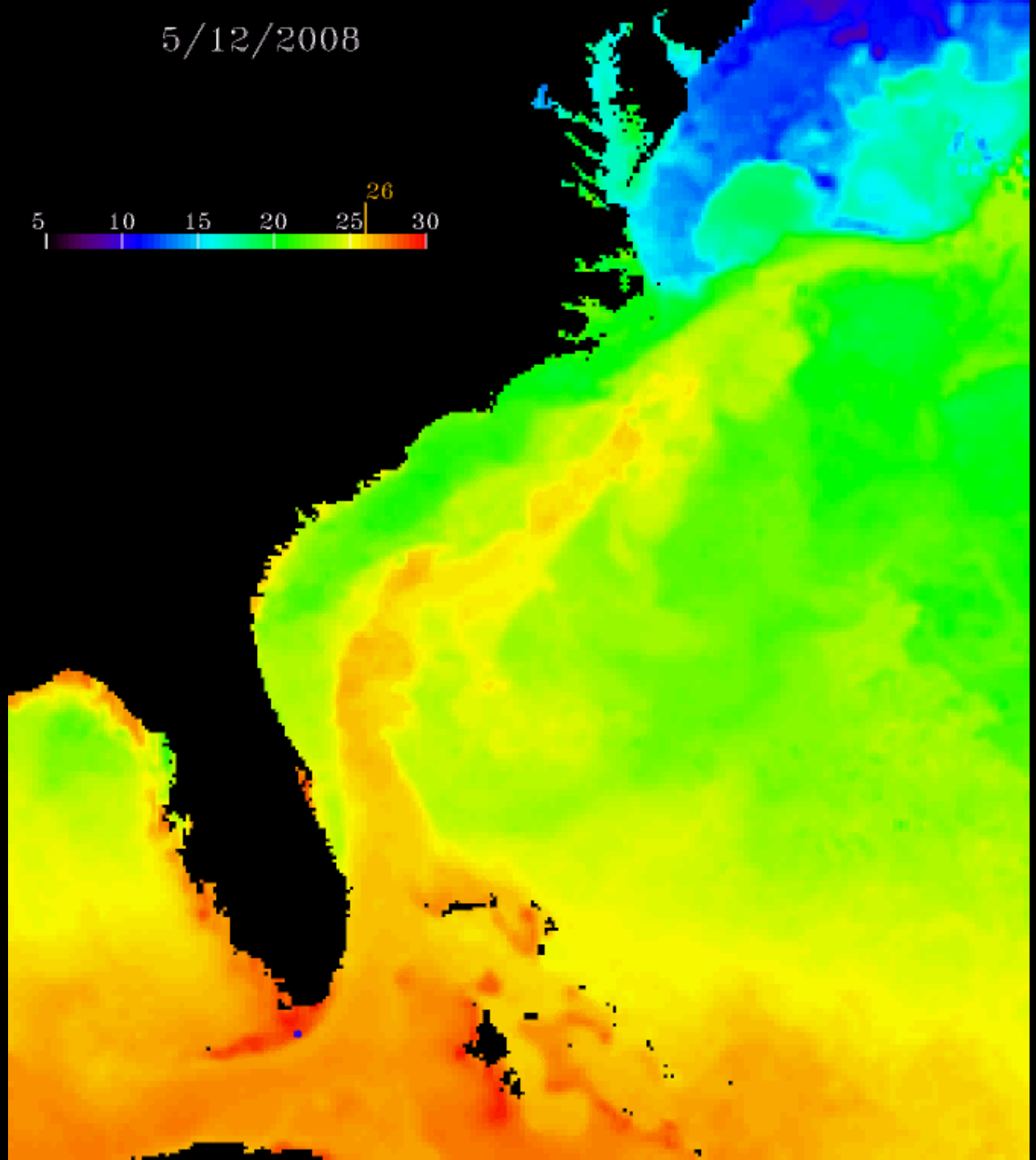


5/12/2008

Orange is Optimal!

26°C (79°F)

T116

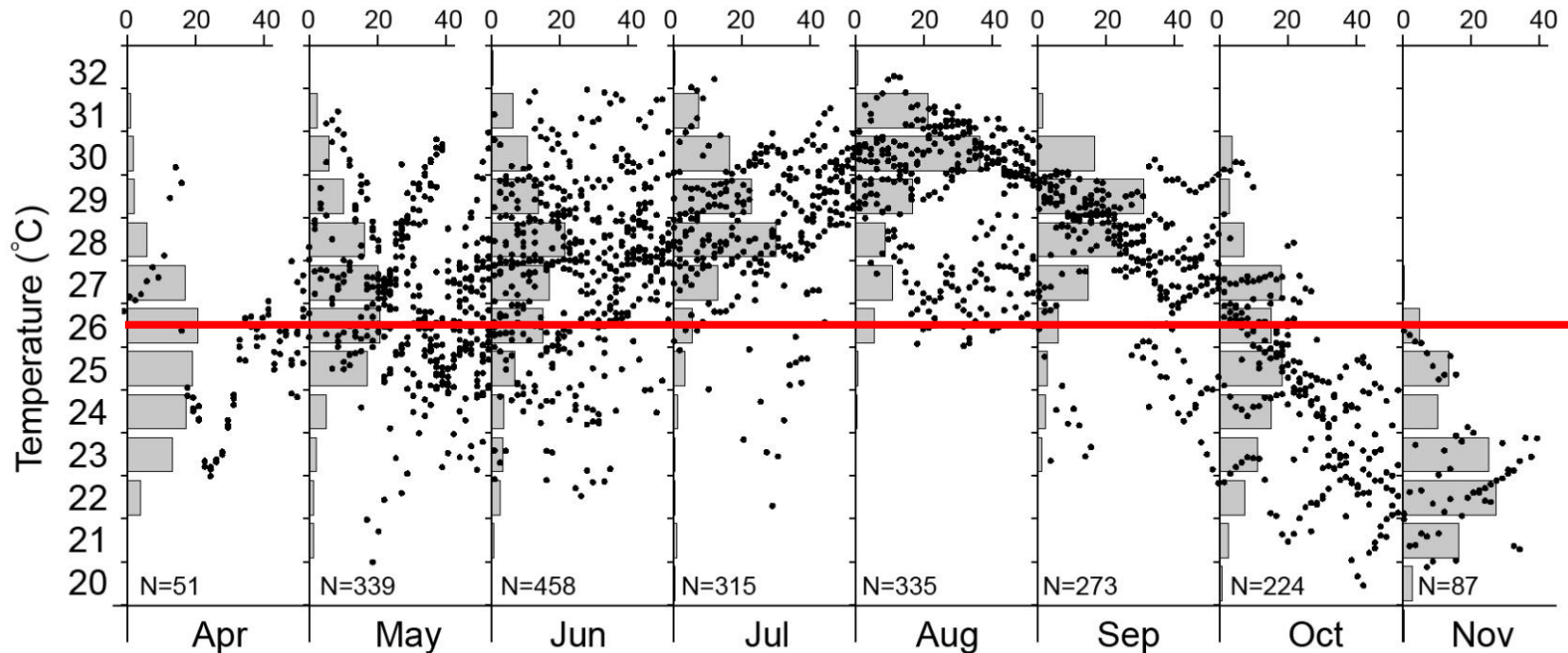


Many fishes also like water temperature  $>26^{\circ}\text{C}$ !

## Water Temperature data from Tarpon satellite PAT-tags



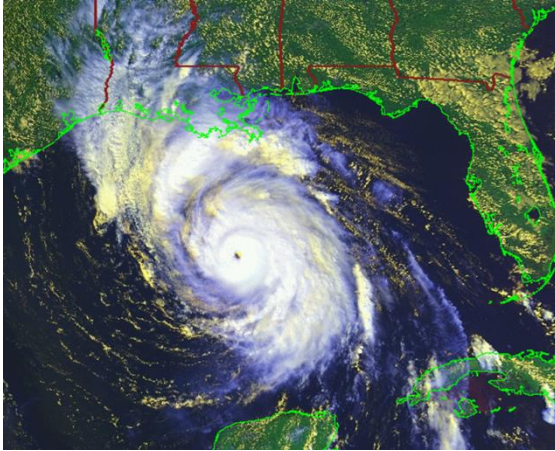
Temperature frequency (%) distribution by month



Daily averages (dots) and monthly frequency distributions (bars).



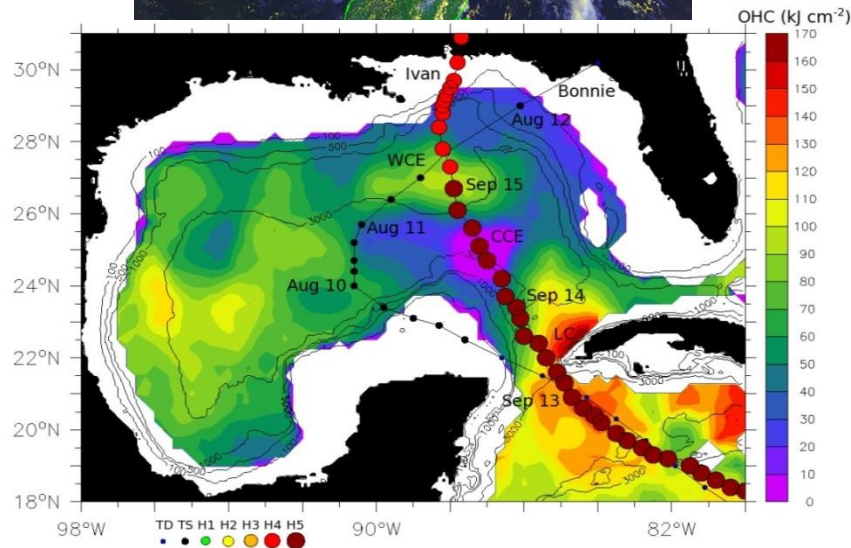
# What is OHC & Who Cares?



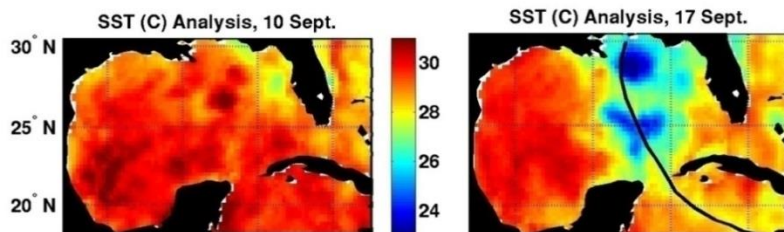
## Ocean Heat Content (OHC)

*“The integrated thermal energy from sea surface to the depth of the 26 °C isotherm”.*

Tropical cyclones are a **BIG** deal!.



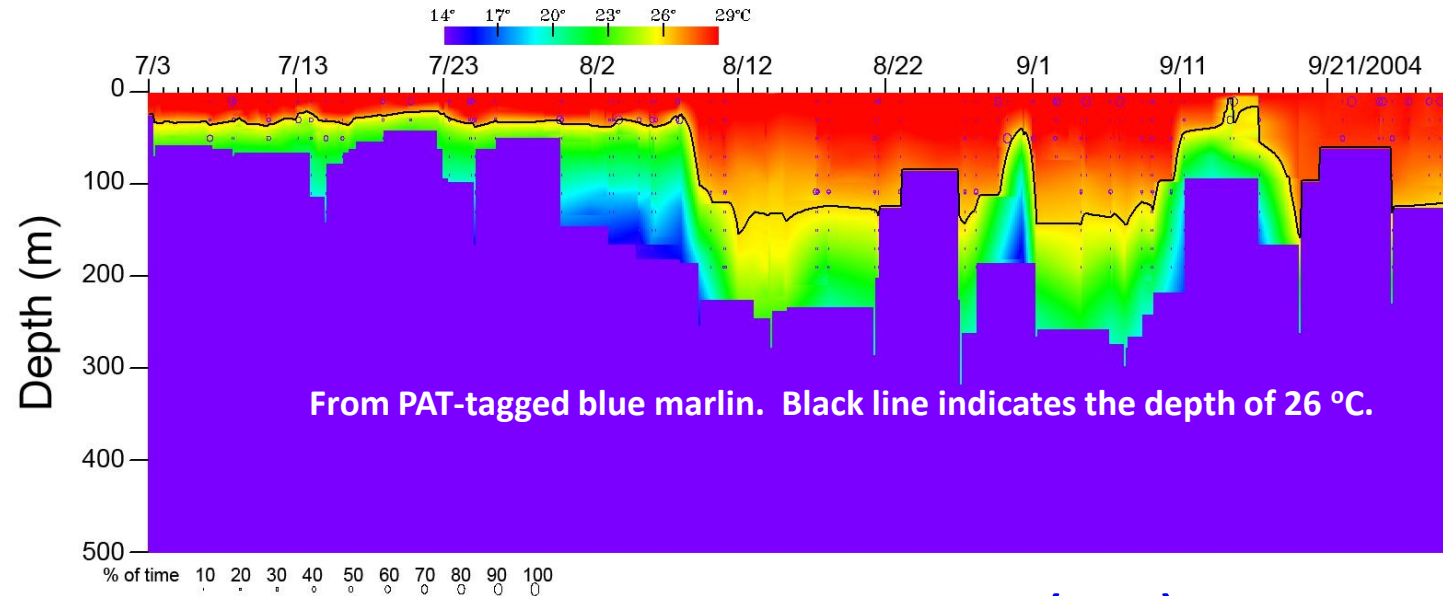
**OHC** during September 15, 2004.



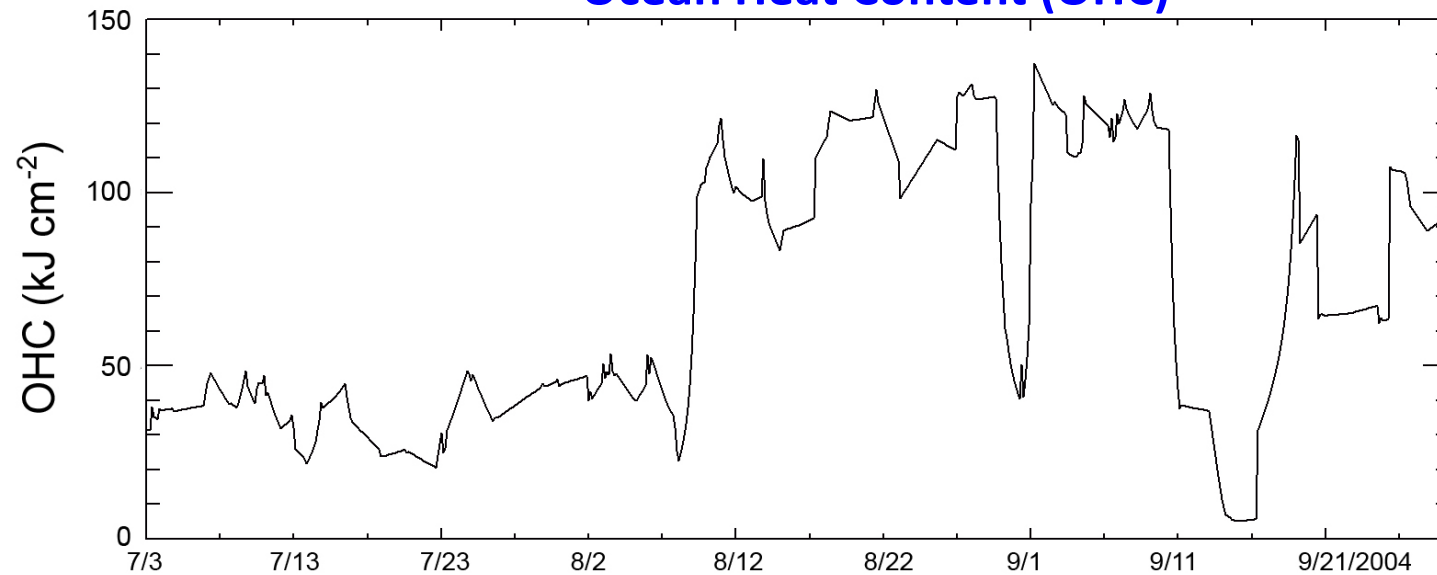
SST before (left) and after (right) the passage of Hurricane Ivan (2004) showing upper ocean cooling.

# How do you get OHC from tag data?

## Depth and Vertical Temperature



## Ocean Heat Content (OHC)





Uniform Sea Surface Temperature

**SST on July 21, 2012**

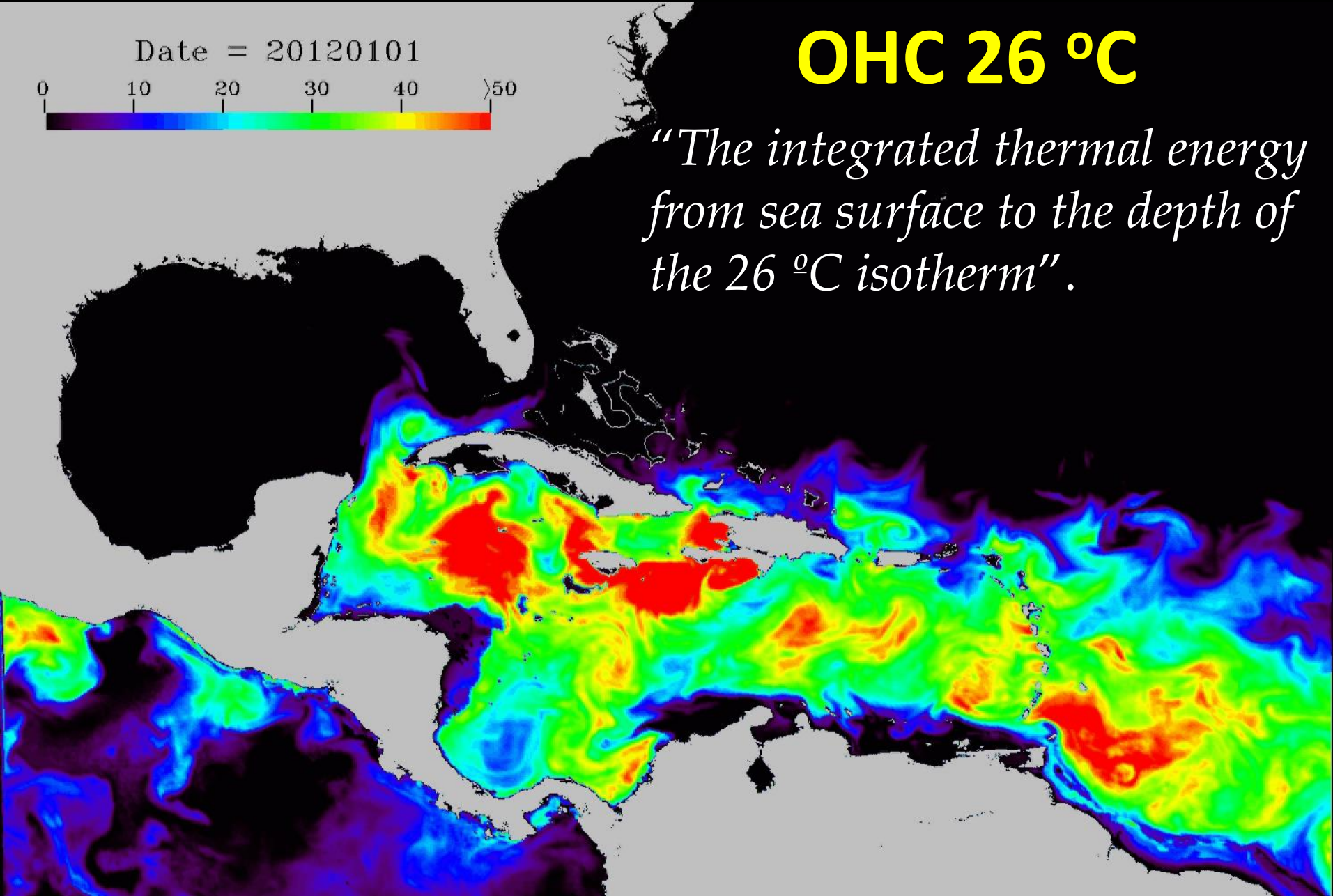


Date = 20120101



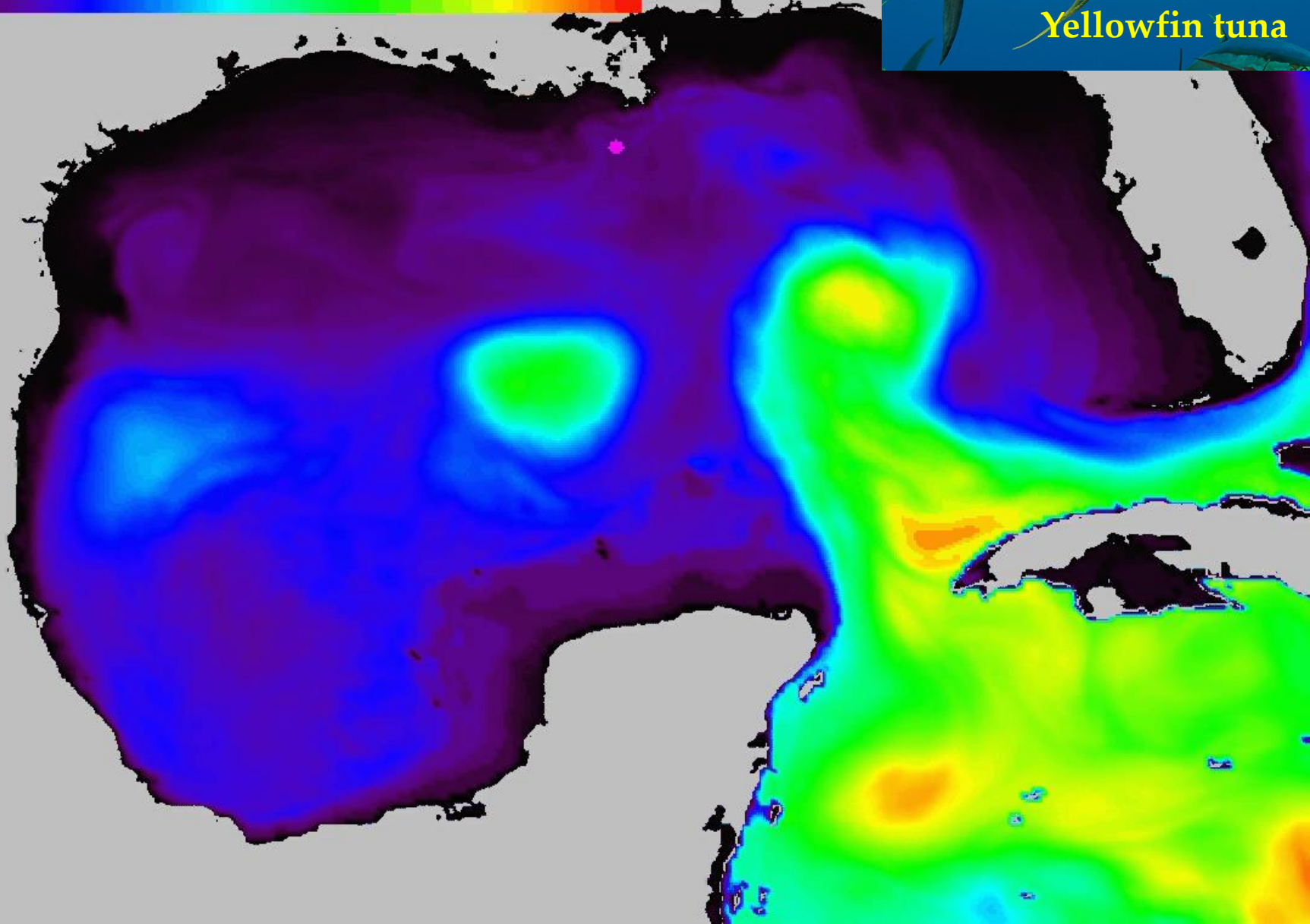
## OHC 26 °C

*“The integrated thermal energy from sea surface to the depth of the 26 °C isotherm”.*





20120315



Yellowfin tuna

Date = 20110906

0 100 200 300 400 >500



White Marlin

